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ABSTRACT

The purpose of this project was broadened to include other science technologies and the curriculum was renamed Science Technology. A survey of employers in the Northern Virginia area indicated that there were employment opportunities in a wide range of science technologies and many laboratory skills are common to all the job activities of currently employed technicians. Based on these findings, curricula for a two-year degree and a one-year certificate were prepared. The science technology components of these curricula were developed as modules, self-instructional, self-pacing, independent units of instruction. A total of 35 modules are currently available. Of these, five were obtained from other sources, two were produced by students, and the remainder were developed by the project director. Some of the modules have been tested by students. Testing the modules by students, revision on the basis of their recommendations, modification of ChemTec materials for the program, and arrangements for the on-the-job training phase of the curricula are being carried out. (Author/KM)

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Annual Report

Project No. 1-C-019
Grant No. OEG-3-71-0078

A PROGRAM FOR THE CREATION OF A BIOTECHNICAL CURRICULUM

David L. Parker and Joan G. Creager

Division of Natural Sciences and Mathematics
Alexandria Campus
Northern Virginia Community College

3443 S. Carlyn Springs Road
Bailey's Crossroads, Virginia 22041

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ABSTRACT

A PROGRAM FOR THE CREATION OF A BIOTECHNICAL CURRICULUM

The original purpose of this project was broadened to include other science technologies and the curriculum was renamed Science Technology.

A survey of employers in the Northern Virginia area indicated that there were employment opportunities in a wide range of science technologies and that there were many laboratory skills common to all of the job activities of currently employed technicians.

Based on these findings and in cooperation with the local curriculum advisory committee, curricula for a two-year degree program and for a one-year certificate program were prepared and submitted for state approval. The science technology components of these curricula were developed as modules, self-instructional, self-pacing, independent units of instruction. A total of 35 modules are currently available for students entering the program in the fall of 1972. Of these, five were obtained from other sources, two were produced by students and the remainder were developed by the project director. Some of the modules have been tested by students.

During the extension of time granted for the completion of this project, the director has been primarily engaged in supervising the efforts of students testing the modules, in revising the existing modules on the basis of recommendations of students testing the modules, in modifying ChemTeC materials for the program, and in making arrangements for the on-the-job training phase of the curricula.

PREFACE

While the original purpose of this project was to develop a biotechnical curriculum for use in a two-year degree program, the purpose of this project was broadened to include other related science technologies. The curriculum has been renamed the Science Technology curriculum. The additional support for the project was provided by Northern Virginia Community College. This support, which significantly exceeded the normal cost sharing arrangements, is gratefully acknowledged.

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Annual Report

A PROGRAM FOR THE CREATION OF A BIOTECHNICAL CURRICULUM

INTRODUCTION

The original purpose of this project was to create a biotechnical curriculum on the Alexandria Campus of Northern Virginia Community College. As indicated in the original proposal, several studies pertaining to technical manpower and opportunities for technical education have demonstrated the need for technical programs. A 1969 study by the National Industrial Conference Board showed that qualified technicians have been in short supply for several years and will remain so into the 1970's unless action is taken to train more technicians. A 1970 report of the National Conference of Post-Secondary Vocational Education prepared by Ohio State University and the U. S. Office of Education assessed vocational-technical programs in each state across the nation. In the state of Virginia, less than 3% of the 18-21 year old population was enrolled in vocational-technical programs while the national average for such enrollments was 4.8%. Furthermore, only fourteen institutions in the state offered technical programs. Commissioner Marland's recent emphasis on career education further substantiates the need for development of programs that go beyond specific vocational training to help students explore a variety of careers and to appreciate the role of their chosen career in the broader context of technology.

The purpose of this project has been broadened to incorporate Commissioner Marland's concept of career education and to accommodate a larger component of technology than the original biotechnical curriculum. This broadening of the scope of the project was necessitated by the variety of employers who responded to the survey which was done very early in the

project. We have renamed the curriculum Science Technology and have included several options; presently chemical technology and biotechnology are being pursued by students.

One of the major objectives of the Alexandria Campus of Northern Virginia Community College is to serve the community of suburban Virginia adjacent to Washington, D. C. by providing training and professional career orientation for the types of employment currently available to citizens of the community. Since the Alexandria Campus did not offer any programs in the science technology area prior to the initiation of this project and since the curriculum development guidelines for the Virginia Community College System encourage the creation of "umbrella" programs wherein there are several options under one administrative unit, it was decided to pursue the development of a Science Technology program with options in biotechnology, chemical technology and environmental technology and to add other options as time permits and the need for new types of technicians arises.

Therefore, the purpose of this project has been redirected to create and implement the initial stages of a science technology curriculum. Significant support beyond the typical cost sharing arrangements has been provided by the college for this expanded project. Continued efforts this fall have focused upon further development of the curriculum. The possibility of developing an electro-chemical technology area has been suggested by one employer.

PROCEDURES

Three classes of procedures were involved in carrying out this project: (1) the survey of employer needs and student aspirations and interests, (2) the development of college-employer cooperative relationships, and

(3) the development, testing and implementation of the initial stages of the curriculum, and (4) re-evaluation and modification of initial materials used in the first quarter of the curriculum.

To assess employer needs a questionnaire was designed to collect pertinent information concerning the number of technicians employed, salary scales, desire to hire technicians who have completed such a program as the one being developed, skills considered necessary or desirable for the tasks technicians currently do, and willingness to cooperate in an on-the-job training program. A copy of the questionnaire is provided in Appendix A. This questionnaire was mailed to 63 laboratories, industries and public offices in the Northern Virginia area in June of 1971. A follow-up letter with a second copy of the questionnaire was mailed to non-respondents in July. Fourteen completed questionnaires were received. An additional twenty-one questionnaires were returned with the notation that the recipient organization does not employ science technicians. Among the non-respondents were schools, departments of public works, recreation departments, and extremely small laboratories which presumably do not hire technicians. Some of the questionnaires were mailed for the purpose of informing the recipient that we were developing a technician training program and therefore a completed response was not anticipated.

To assess student interests and aspirations and to determine the extent to which these match employer needs, we had planned to obtain a group of students currently enrolled in other programs to participate in a series of trips to various laboratories and in discussion groups designed

to determine the degree of commonality between student aspirations and anticipated employer needs. Since this turned out to be an unworkable plan because students apparently do not participate in such non-remunerative activities, we modified the plan to offer independent study credit to students who participated in the project by testing modules. About eight students initially were involved in the project; one has worked continuously throughout the academic year. Our experience indicated that it was very difficult to generate student interest until the curriculum was actually approved and incorporated in the college catalog. During the Fall Quarter of this academic year, five students have been enrolled in the approved program and have been using the modularized instructional method.

The procedure for assessing student interest has been revised. A module called "Introduction to Science Technology" has been prepared and is being used to explain the program and recruit interested students. A course entitled "Careers in Science Technology" is being incorporated into the first quarter of the curriculum to insure that students learn early in the curriculum about the career opportunities available to them. The introductory module and the course, which will be described in more detail later in this report, are mentioned at this point to illustrate methods for assessing student interests and aspirations.

The procedures for developing college-employer relationships included the appointment of an advisory committee for the curriculum consisting of representatives of a variety of employers of science technicians. This committee was selected from the community and appointed by the president

of the college according to established procedures of the college. Information from the survey of employers was used to select laboratories to participate in the on-the-job training aspects of the curriculum. Several potential employers were identified and they will be contacted to work out detailed cooperative arrangements when students become enrolled in the program. The director of this project is working in close association with the college's director of the cooperative education program to take advantage of his expertise in arranging for on-the-job learning experiences. The appointed committee (meeting once during each quarter) has enabled the director to define the options (biotechnology and chemical technology) more precisely and facilitate future employment arrangements.

Several procedures were used for developing, testing, and implementing the initial stages of the curriculum. Based on college policies and input from the advisory committee, it was decided to develop a two-year program leading to an Associate in Applied Science degree in Science Technician Aide. Therefore, an overall curriculum for each of these programs was prepared and submitted to the Virginia Community College System for approval. A course description was also prepared for each proposed new course. The curricula and the course descriptions are given in Appendix B. In July the Virginia Community College State Council approved the curriculum--Science Technology. Unfortunately because of the late approval and delayed publication of brochures and general public information, the initial group entering the program numbered four (handled on a lecture-laboratory-independent study basis).

In the original proposal for this project, plans were made to visit other colleges to survey programs and to obtain consultants to advise us in the development of the curriculum. One role of a consultant was to have been to maintain interaction with the American Institute of Biological Sciences' Project BIOTECH. These activities were carried out at no expense to the project since the initial director has maintained a close working association with the staff of Project BIOTECH (as part-time staff biologist for the Education Division of AIBS) and has had occasion to visit several colleges and survey their technical programs while conducting other business such as workshops on the development of modules. The present director for the extension period (ending December 15th) visited one college to observe an open laboratory program of study and view the development of a TV-module designed to teach a laboratory skill. Further travel and observation was prohibitive due to the instructional demands associated with the new program.

The procedure used for developing modules followed the outline in Publication No. 31 of the Commission on Undergraduate Education in the Biological Sciences entitled The Use of Modules in College Biology Teaching. (Copies of sections of the publication are provided with this report.) The list of modules to be developed was based largely on information from the employer survey in which employers indicated which skills were necessary or desirable among the tasks their technicians carry out. While most of the modules were developed by the project director, several of the students participating in the project developed modules on topics of interest to them. Two of these modules were appropriate for inclusion in the curriculum. In addition to developing modules, we were constantly

alert to other sources of modules suitable for inclusion in the curriculum. Four modules were purchased from commercial sources and one was made available to us for testing purposes from the Purdue Minicourse Project, directed by Dr. S. N. Postlethwait.

A module evaluation form for student testing of modules, shown in Appendix C, was prepared. Each student was requested to complete this evaluation for each module tested. The evaluation procedure has been helpful in improving the modules.

As the list of completed modules grew and the content of the modularized science technology courses began to take shape, a flow-chart of completed and proposed modules was prepared. The current flow-chart and the options for biotechnicians and chemical technicians are shown in Appendix D.

Plans for implementing the initial phase of this program was carried out during the summer and fall of 1972. The director began making plans for cooperative on-the-job training with several employers in the area, teaching the first courses to be offered in the program, having students evaluate the modules as they use them, revising modules as time permitted and the needs arose, and adapting materials from ChemTeC for the program.

The other courses in the curriculum will be offered in other divisions of the college and probably will not be modularized. Students will develop communication and mathematical skills and will have the opportunity to select courses from the social and natural sciences. Two specialized courses, one in technical writing and one in data processing, will provide opportunities to master additional skills frequently needed by technicians.

The curriculum for the one-year Certificate program parallels closely the first year of the two-year program except that the mathematics course recommended is less demanding. It would be relatively easy for a student who started out in one program to elect to change to the other with very little loss of credits.

Of all the activities of this project, the greatest amount of effort was placed on the development of modules because most other aspects of the program depend on the availability of modules for the college-based science technology courses. Now that forty-five modules are completed, they are being used by students beginning the program this fall. They are being used to demonstrate the concept of modularized instruction to other divisions of the college and to employers considering setting up cooperative on-the-job training. Since modules are a relatively new mode of instruction, there is a general lack of understanding of what they are and how they are used in tailoring curricula to meet individual student needs. As a result of the modules developed, we are in a position to demonstrate some of the advantages of modules. Students become independent learners and they can work at their own pace to master learning materials. With modules incorporated into the systems approach to learning, mastery becomes the goal and the time required to master a module can vary. In contrast, traditional teaching has usually set a time limit such as three lectures per week for a quarter or semester and there was much variation in the level of mastery attained by the students, all whom were expected to go through the course at the same pace.

Modularized instruction is sometimes perceived by instructors as an automated mode of instruction which makes the teacher obsolete. This is a

serious misconception. Modules do free teachers from repetitive preparations of routine teaching materials. The teacher's role changes to that of a manager and facilitator of learning. The teacher responds to individual students when they have particular needs. The teacher encourages, counsels, motivates and enriches the experiences of students. In short, through the use of a modularized learning system, the teacher is free to do what only people can do! All of the modules developed in this project follow the module format provided on page 5 of CUEBS Publication No. 21 (included with this report). Each module has nine components:

1. STATEMENT OF PURPOSE - a brief statement of what the student will learn.
2. DESIRABLE PREREQUISITE SKILLS - skills a student should have mastered before beginning a particular module.
3. INSTRUCTIONAL OBJECTIVES - a list of the skills or concepts to be mastered stated in behavioral terms.
4. DIAGNOSTIC PRE-TEST - a written or demonstration test to determine either whether a student has mastered the prerequisites of the module or whether the student has mastered the module and need not do it.
5. IMPLEMENTERS - all of the materials needed to complete the module including laboratory equipment and audiovisual aids.
6. THE MODULAR PROGRAM - the instructions to the student for what to do to master the objectives; can include programmed instruction, audio tape, laboratory activities, etc.
7. RELATED EXPERIENCES - suggestions for modules which logically follow the one just completed or for other experiences the student is now ready to do.
8. EVALUATIVE POST-TEST - a written or demonstration test to determine whether the student has mastered the objectives of the module.
9. ASSESSMENT OF THE MODULE - an evaluation of the quality of the module which is done by completing a module evaluation form like the one in Appendix C.

A total of forty-five modules are currently available for students entering the program in the Fall of 1973. The titles of these modules are as follows:

MODULES FOR THE SCIENCE TECHNOLOGY PROGRAM (FALL 1973)

Introduction

Introduction to Science Technology

Safety in the Laboratory

Basic Chemical Laboratory Practice

Chemical Literature and the Library

Record Keeping

Hazards--Electricity and Compressed Gases

Toxicity of Chemicals

Skills

Simple Balances

Compound Light Microscope

Metric Measurement

Paper Chromatography

pH Meter

Analytical Balance (manual)

Analytical Balance (automatic)

Dissecting Microscope

Computations

Slide Rule

Biostatistics

Insect Identification

Water Analysis

Blood Smear Techniques

Aseptic Technique

Preparation of Sterile Media

Pipetting (including syringes)

Basic Chemistry Modules (using programmed text)

Introduction to Chemistry

Atoms, Molecules and Periodic Table

Oxides, Acids, Bases and Salts

Chemical Calculations

Gas Laws

Solutions (Part I)

Solutions (Part II)

Colloids

Nuclear Chemistry - Radiation Biology

Organic Chemistry

Biochemistry

Basic Biology Modules (using NVCC study guide)

Basic Ecology

Energy in Living Systems

Cell Structure and Function

Mammalian Anatomy and Physiology I (digest., respir., circ. and urogenital systems)

Mammalian Anatomy and Physiology II (endocrine, sensory, nervous, effector sys.)

Classification and Taxonomy

Evolution

Genetics and Gene Action

Growth and Development

Animal Behavior

Notice that the modules listed here correspond quite closely with the skills considered essential or desirable by employers in the area. Of the modules listed, Analytical Balance and Insect Identification were prepared by students. Recently a module on the use of the Mettler Analytical Balance is being prepared by a student. The Module, Aseptic Technique, was provided to us for testing by the Purdue Minicourse Project. The following modules were developed from commercially available materials:

Basic Chemical Laboratory Skills

Toxicity of Chemicals
Safety in the Laboratory
Hazards--Electricity and Compressed Gases
Solutions--(6B)
Paper Chromatography
Metric Measurements
Water Analysis
Blood Smear Technique
Basic Blood Typing

Many of the modules include some component of commercially available materials. The exact materials used are specified in Abstracts of Modules: Appendix E. These abstracts include the statement of purpose, the instructional objectives and the implementers as they are listed in the modules for the students. All nine components of each module have been completed.

As the modularized curriculum began to take shape a flow chart of modules, completed or planned, was prepared as shown in Appendix D. Optional pathways through the curriculum are also shown in Appendix D for biotechnicians and chemical technicians.

It should be noted that the flow charts include some modules which are presently being developed. Several modules (i.e., Basic Chemical Laboratory Skills) have been prepared by adapting materials from a new set of publications, Modern Chemical Technology. This set of publications consists of a guide book and ten volumes of materials designed to train chemical technicians. The materials were prepared for use in two-year colleges by Project Chem Tec, Lawrence Hall of Science, Berkeley, California. Modules 34 and 35 will be developed by our staff or obtained from Project BIOTECH as time and funds permit. The plan for this curriculum calls for the addition of new modules as they are needed to train technicians for the jobs available in the Northern Virginia Area. Materials produced in other projects such as the ones mentioned above, will be incorporated into the curriculum as deemed appropriate.

A total of 60 modules evaluation sheets have been collected from students participating in the project.

Six students evaluated the original version of Module 1--Record Keeping and Module 3--Compound Light Microscope. Their ideas were incorporated into the current revised versions of these modules. Revisions of the Basic Chemistry Modules have proven quite valuable in the students' performances.

All of the modules that have been completed are packed in plastic "shoe box" size containers and are ready to be used by students when the program is implemented in the fall. Slide viewers, tape players and headphones have been purchased to supply six stations at which students will work on skill modules. Programmed instruction and reference books

sufficient for at least twelve students to work simultaneously have been placed on reserve in the learning resources center. Career information materials are also available for student use.

CONCLUSIONS

- The survey of employers effectively determined the nature of employment available and the skills needed in science technologies.

- While some progress was made in developing college-employer cooperative on-the-job training programs and some assessment of student interests and aspirations was possible, we discovered that both of these processes are greatly facilitated by having a significant portion of the curriculum developed. During the extension time period of this grant, we expect to develop cooperative on-the-job training arrangements and to elicit much greater student interest in the curriculum.

- The forty-five modules, which have been completed, have served very well as a core of learning experiences for the college-based courses during the first year of operation of the program.

- Since modularized instruction is a relatively new mode of instruction, a significant portion of the effort in this project was associated with acquainting people with the advantages of modules and the methods of modularized instruction.

RESULTS

The results of each of the three classes of procedures will be reported separately: (1) results of the surveys of employer needs and student aspirations (2) progress in developing college-employer cooperative relationships, and (3) results of the development, testing and implementation of the initial stages of the curriculum.

Of the fourteen employers responding to the survey of employer needs the following pattern of current and projected employment for technicians was obtained:

Number of technicians currently employed	Number of employers reporting	Number of technicians to be hired in 1972	Number of employers reporting	Number of technicians to be hired in 1973	Number of employers reporting
none*	2	none*	3	none*	1
1-9	4	5-10	3	1-2	3
10-25	3	11-20	4	10-20	4
26-99	2			30+	1
100+	2				
no response**	1	no response**	4	no response**	5

*Those not currently hiring technicians indicated plans to do so in the near future.
**No response does not necessarily imply that no technicians are to be hired. Some respondents were explicit in stating that the number of technicians they expect to hire is confidential information.

Six respondents indicated that they have difficulty in hiring competent well-trained technicians and all six indicated that a technician training program at Northern Virginia Community College would be of benefit to them.

With regard to salaries which would be offered to technicians with two years of post-secondary education, the range of values for annual salaries was from $5200 to $8000. Since these data were obtained during the summer of 1971, they may have changed since that time.

Five respondents indicated that they already operate on-the-job training programs. Seven respondents are interested in discussing the possibility of participating in a cooperative on-the-job training program in conjunction with the science technology program being developed at the college.

To determine whether opportunities would be available for students to tour laboratories and observe technicians at work, we asked whether respondents would be willing to arrange tours for students; ten of the fourteen respondents indicated that they would arrange tours.

A list of skills and concepts which might be used in various technical jobs was provided on the questionnaire (See Appendix A.) The following is a tabulation of the number of times each skill or concept was indicated by an employer to be essential o desirable. Items that were checked fewer than five times are omitted from the list.

Skill	Number of employers
record keeping	14
care and cleaning of glassware	12
pH meter	12
simple balances	12
analytic balances	11
microscopic techniques	11
colorimeter	11
pipetting	11
solution preparation	11
computations	10
spectrophotometer	10
titrations	10
metric measurements	9
culturing of bacteria	8
media preparation	8
serial dilutions	8
autoclaving	7
bacterial staining	7
clinical centrifuge	7
colony counting	7
ion exchange columns	7
Spectronic 20	7

Skill	Number of employers
chromatography (any type)	6
slide making	6
use and care of syringes	6
microtome	5
specimen preparation	5
transferring cultures	5
Concepts	
chemical formulas, valences and equations	7
basic biochemistry	6
gas laws	6
anatomy and physiology (mammals)	5
ionization-acid-base chemistry	5

Items not on quesionnaire but mentioned by employers

laboratory safety
biostatistics
blood analysis
environmental science techniques
various types of automated equipment
slide rule
key punch and data processing

The results of various efforts to assess student aspirations and interest in the curriculum have not been entirely satisfactory. After trying several methods already described, we developed a module entitled "Introduction to Science Technology." This module can be used by individual prospective students or can be presented to a group. It describes what a module is, what components a module contains, the advantages of modularized instruction. It also explains the curriculum and the options available to students such as the choice of a two-year AAS degree or a one-year certificate program and the choice of what branch of science technology to emphasize (biotechnology, chemical technology, etc.). The module also describes how an "umbrella" program can offer several types of technology under one administrative unit. This module is available

for presentation at local high schools, to employers who would like to encourage their technicians to obtain additional training, and to any citizens groups interested in learning about new educational programs.

We have incorporated in the curriculum a one-quarter course on Careers in Science Technology. This course will meet once a week for three hours to enable the class to visit laboratories and observe first-hand what kinds of jobs technicians do. These field trips will be coupled with class discussion, visiting speakers and other activities designed to acquaint the student with the curriculum and the opportunities it provides. By providing these experiences early in the curriculum, we hope to assist students in determining whether their career aspirations match the employer needs before they have invested a long period of study in preparing for a career that turns out not to be appropriate for them.

The results of the survey of employers indicate that the means used was effective in obtaining the information needed to plan the initial stages of a curriculum. While the first attempts to survey student interests and aspirations were not totally successful, we did learn that a significant portion of a program must be developed before it is possible to be able to engender student interest in the program.

The results of our efforts to develop cooperative college-employer relationships are twofold. First, we have a good working relationship with the members of the advisory committee and several individuals on that committee have provided information needed in the curriculum development. For example, several of these individuals provided us with sample data forms to incorporate in our module on record keeping. This makes it possible for us to show students what kinds of records technicians keep

and to provide a touch of realism to the first skill module a student will do.

Second, from the employer survey, we have the assurance that several employers representing a variety of technical positions will cooperate with us in planning and implementing on-the-job training experiences. Because it is difficult to plan the details of such training experiences until there are students in the program and we have some idea of their interests, the detailed planning has been deferred. During the extended time period which has been granted for the completion of this project, the new director of the project will make arrangements for on-the-job training.

As with the assessment of student aspirations, the arrangement of on-the-job training experiences can now be done more efficiently because a significant portion of the college-based science technology courses is available. The director can show the employers what kind of skills the students will have mastered before they begin their on-the-job training.

During the tenure of this project, the college has obtained funds for a cooperative education program which extends across all divisions of the college. We have made arrangements with the director of this program to assist us with the placement of our students in on-the-job training situations.

The results of our overall curriculum planning provided a detailed curriculum for the AAS degree in Science Technology and one for the Certificate as Science Technician Aide. These curricula and the new courses proposed are provided in Appendix B. Some of the highlights of these curricula and courses are reported below.

As shown in the curriculum for the AAS degree in Science Technology, there are four types of science technology courses: (1) Careers in Science Technology, (2) three one-quarter courses in Basic Techniques and two one-quarter courses in Advanced Techniques, (3) two courses in Applied Techniques and three courses in Advanced Applications, and (4) Technology of the Future. The Careers in Science Technology course has already been described. The Basic Techniques courses are first-year courses and the Advanced Techniques courses are second-year courses. These courses will be taught at the college and will make use of modules to enable students to master skills at their own rate. The courses in Applied Techniques and Advanced Applications are intended to be given in on-the-job settings. As laid out in the curriculum, these courses would be spread over five quarters and would start with the second quarter of the curriculum so that students would have learned some basic techniques and have completed the careers course before beginning the on-the-job training. It may turn out that students will register for more than one of these courses concurrently in order to receive credit for a full-time work experience. In this case, a student could register for more than one of the basic or advanced technique courses in another quarter.

The Technology for the Future course is designed to be offered during the final quarter of the curriculum and to give students an overview of possible technological changes. We intend that students should learn to keep abreast of changes in their field and that they should learn on their own so that they can master new skills as the need arises. We want our students to be competent and well-trained in the skills needed on the jobs currently available but we also want them to have the flexibility and foresight to anticipate changes and cope with them effectively.

APPENDIX A

(Summer 1971)

SURVEY OF SCIENCE TECHNICIAN EMPLOYERS

Name of Respondent_____ Phone_____

Position_____ Organization_____

Street Address_____ City_____ St._____ Zip_____

1. What types of science technicians with two years (or less) training would you hire?

_____

2. How many technicians do you presently employ? _____ expect to hire in 1972____ in 73____
3. Do you have difficulty hiring competent technicians? ___Yes ___No
   If so, would a technician training program at NVCC be of benefit to you? ___Yes ___No
4. What is the approximate starting salary of a new technician with two years of post-secondary training? (Salary data will be kept completely confidential.) $_____
5. Please indicate which of the following skills and concepts would be most necessary for your technicians. Indicate essential items with an E, desirable with a D.

___animal care
___animal inoculation
___autoclaving
___bacterial staining
___bacterial culturing
___balances, analytical
___balances, simple
___clinical centrifuge
___chromatography
type_____
___colony counting
___computations
___glass ware(care & cleaning)
___ion exchange columns
___media making
___manometric techniques
___metric measurements
___microscopic technique
type _____
___microtome
___pH meter
___colorimeter
___Spectronic 20
___automated equipment
type_____
_____
_____
_____

___pipetting
___radiation techniques
___record keeping
___serial dilution
___slide making
___tissue preparation
___solution preparation
___specimen preparation
type_____
___spectrophotometer
___syringe (use & care)
___tissue culture
___titration
___transfer techniques (cultures)

Please write in any other skills particularly useful in your laboratory.

_____
_____
_____
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_____

___cyclic properties of ecosystems
___cell structure and function
___basic biochemistry
___energy flow in living systems
___anatomy & physiology
which organisms?
_____
_____
_____
___regulatory mechanisms in living things
___animal behavior
___growth and development
___basic genetics
___gene action
___radiation effects
___evolution
___atomic theory
___gas laws
___chemical formulas, valences and equations
___ionization, acid-base chem.
___other concepts
_____
_____

6. Do you presently have any on-the-job training programs in operation? ___Yes ___No
   If so, please describe briefly.
   _____

_____

7. Would you be willing to have groups of students make scheduled tours of your lab? ___Yes ___No
8. Would you be interested in discussing the possibility of a cooperative college/on-the-job science technician program? ___Yes ___No

Thank you for your assistance.

Please return this questionnaire to: Dr. Jean G. Granger, Div. of Science and Mathematics, Eastern Campus, Northern Virginia Community College, 3443 S. Carlyn Springs Rd., Bailey's Crossroads, Va. 22041

___Check here if I may visit your laboratory to discuss this program.

APPENDIX B

SCIENCE TECHNOLOGY

(Easton Campus)

Pending Approval by the State Council of Higher Education

Degree: Associate in Applied Science

Length: Six Quarters (two years)

Purpose: The curriculum is designed to accomplish two purposes: to prepare students to enter employment in a variety of technical careers and to provide those now employed in technical occupations the opportunity to upgrade their skills.

Occupational Objectives:

Biomedical clinical technician
Chemical technician
Environmental technician (air, water, solid waste control)
Research technician

Admission Requirements: In addition to the admission requirements established for the College, a student interested in the curriculum will be scheduled for an interview with a faculty member and will be asked to complete a background questionnaire on which placement within the program will be based.

Curriculum Requirements: The curriculum is designed to provide needed general education and related area study as well as theory and practice in the science technologies. The specific course content is modularized and is presented in a laboratory environment, either at the College or within the community in science and research labs. The curriculum is designed to allow for flexibility of direction within the spectrum of the sciences to help meet the needs for technicians within the various areas. The modularized format allows mastery of the necessary skills and knowledges with an individualized approach. Upon successful completion of the curriculum, the graduate will be awarded the Associate in Applied Science Degree in Science Technology.

SCIENCE TECHNOLOGY

Course Number		Course Title	Course Credits
		FIRST QUARTER	
ENGL	101	Communication Skills I	3
MATH	121	Technical Math I	5
GENL	105	Orientation	1
SCTE	110	Careers in Science Technology	1
SCTE	101	Science Technology Techniques I	3
PHED	100	Fundamentals of Physical Activity	1
		Social Science Elective*	3
		Total	17
		SECOND QUARTER	
ENGL	102	Communication Skills II	3
MATH	122	Technical Math II	5
SCTE	102	Science Technology Techniques II	3
SCTE	124	Applied Science Techniques I	2
		Social Science Elective*	3
PHED		Physical Education Elective	1
		Total	17

Course Number		Course Title	Course Credits
		THIRD QUARTER	
ENGL	121	Technical Writing	3
MATH	122	Technical Math III	5
SCTE	124	Science Technology Techniques III	3
SCTE	126	Applied Science Techniques II	3
		Social Science Elective	2
PHED		Physical Education Elective	1
		Total	17
		FOURTH QUARTER	
SCTE	224	Science Technology Techniques IV	3
SCTE	221	Science Technology Applications I	5
DAPR	105	Principles of Data Processing	3
		Science Elective	4
		Elective	2
		Social Science Elective	3
		Total	18
		FIFTH QUARTER	
SCTE	225	Science Technology Techniques V	3
SCTE	222	Science Technology Applications II	5
		Social Science Elective	3
		Science Elective	4
		Elective	3
		Total	18
		SIXTH QUARTER	
SCTE	230	Seminar & Project (Technology of the Future)	3
SCTE	223	Science Technology Applications III	5
		Social Science Elective	3
		Science Elective	4
		Elective	3
		Total	18
		Total Minimum Credits for the Science Technician A.A.S. Degree	97

* Social Science courses may be chosen from the following: Man, His Institutions, Psychology, Social Science Elective, Economics.

SCIENCE TECHNICIAN AIDE

(Eastern Campus)

Pending Approval by the State Council of Higher Education

Degree: Certificate

Length: Nine Quarters (two years)

Purpose: The certificate curriculum for Science Technician Aide is designed to provide an opportunity for students to develop vocational competency either as an entry into permanent employment or as an entry into temporary employment until such time as the student decides to further his education.

Occupational Objectives: The Science Technician Aide can expect to locate his employment in industry, agencies of government, laboratories, or research centers where he may assist engineers, scientists, and technicians in research, testing, and development related to physical sciences and chemical technology activities.

SCIENCE TECHNICIAN

Course Number	Course Title	Course Credits
	FIRST QUARTER	
ENGL 101	Communication Skills I	3
MATH 11	Elements of Mathematics I*	3
GENL 100	Orientation	1
SCIE 110	Careers in Science Technology	1
SCIE 101	Science Technology Techniques I	3
	Social Science Elective**	3
	Total	14
	SECOND QUARTER	
ENGL 102	Communication Skills II	3
MATH 12	Elements of Mathematics II*	3
	Social Science Elective**	3
SCIE 102	Science Technology Techniques II	3
SCIE 124	Applied Science Techniques I	3
	Total	15
	THIRD QUARTER	
ENGL 137	Technical Writing	3
MATH 13	Elements of Mathematics III*	3
DAPR 102	Principles of Data Processing	3
SCIE 103	Science Technology Techniques III	3
SCIE 125	Applied Science Techniques II	3
	Total	15
	Total Minimum Credits for the Science Technician Aide Certificate	44

* Students may select MATH 121, 122, 123 instead of MATH 11, 12, 13.

** Social Science Electives should be selected from Psychology, Economics, or Sociology.

COURSE DESCRIPTIONS

APPENDIX C

MODULE EVALUATION SHEET

Name of Module _____ Name of Evaluator _____

I. Please rate the overall module on the following items. Circle your response.

a) Did you enjoy the module?	no	Only a little	It was OK	Very enjoyable
b) Was it presented clearly?	no	Some of it	Most of it	Yes
c) Did the parts of the module fit together well?	no	Not very well	Reasonably well	Yes
d) Was the length of the module suitable to the task?	Too long	The right length	Too short	
e) Did the module allow you to work at your own speed?	no	Parts of it did	Most of it did	Yes
f) Would you like doing what you learned in a job setting?	no	Could stand it	Would be OK	Like very much

II. Please rate each of the following parts of a module wherever appropriate.

A. Written instructions: If you circle "no" or "sometimes" please explain on back of page.

1) Were the objectives of the module clearly stated?	no	sometimes	yes
2) Were the written instructions interesting?	no	sometimes	yes

B. Activities: Explain "no" or "sometimes" answers.

1) Were directions for activities clear?	no	sometimes	yes
2) Did the activities help you accomplish objectives?	no	sometimes	yes
3) Did you feel that you were actually involved in doing the module?	no	sometimes	yes

C. Visual aids: Explain "no" and "sometimes" answers. (slides, filmstrips, film loops, transparancies)

1) Did the visual aids help to explain the topic?	no	sometimes	yes
2) Were the visuals clearly presented?	no	sometimes	yes

3) Were the visuals interesting? no sometimes yes

4) Was the amount of visual material appropriate? no sometimes yes

C. Audio tapes: Explain "no" and "sometimes" answers.

1) Was the voice pleasant and easy to listen to? no sometimes yes

2) Was the explanination clearly presented? no sometimes yes

3) Was the rate of speech on the tape satisfactory? Too slow about right Too fast

III. How much time did you spend working on the module? _____hours _____min.

Did you master the module? _____Yes _____No At what percentage level? _____%

Was the amount of time required to do this module appropriate to the job being learned?

Needed more time About the right amount Too much time

Do you now feel competent to do the job you learned in a work situation?

No Somewhat Yes

IV. How would you change the module if you were to write it over?

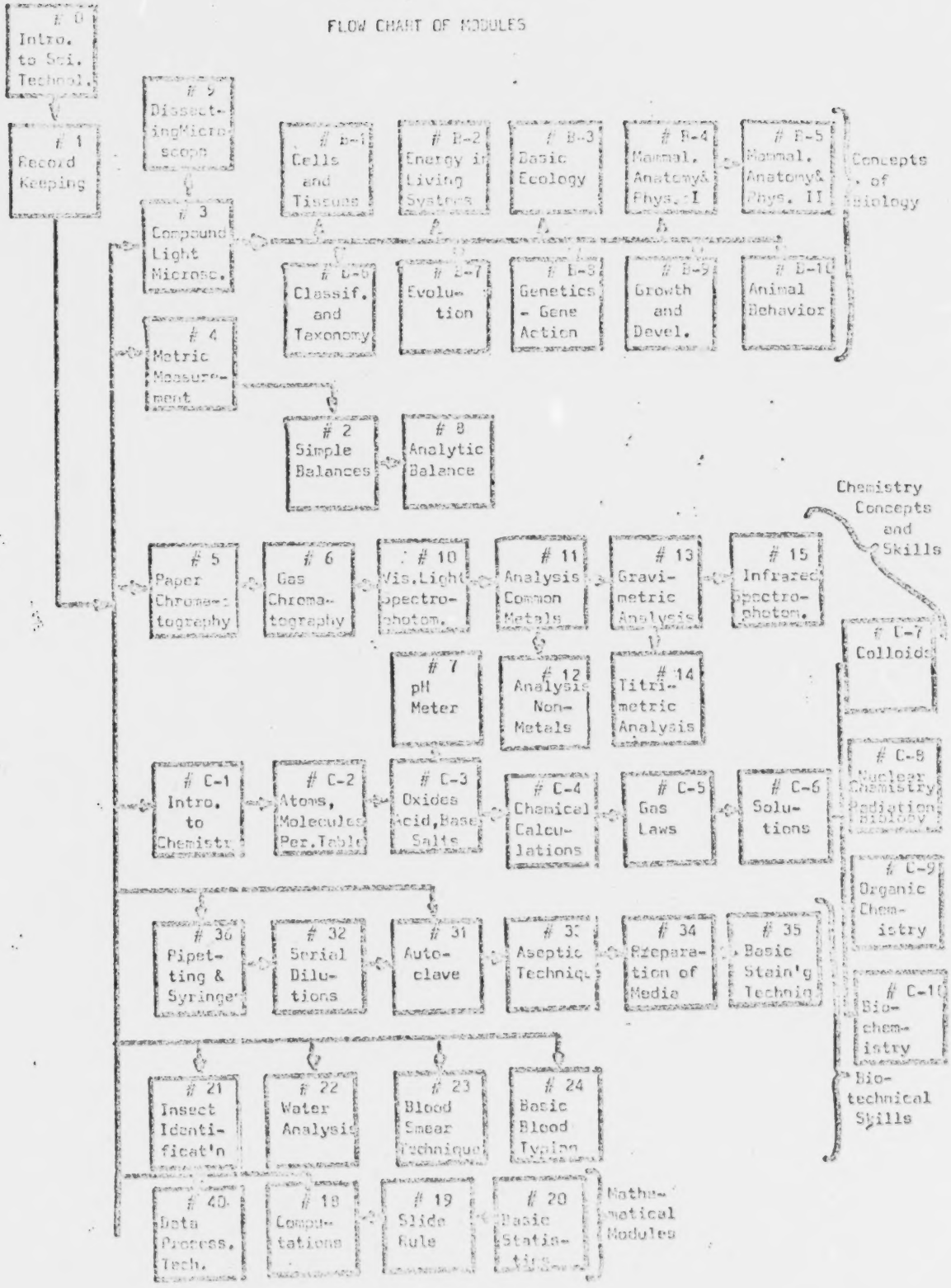
V. What other questions would you ask if you were evaluating a module?

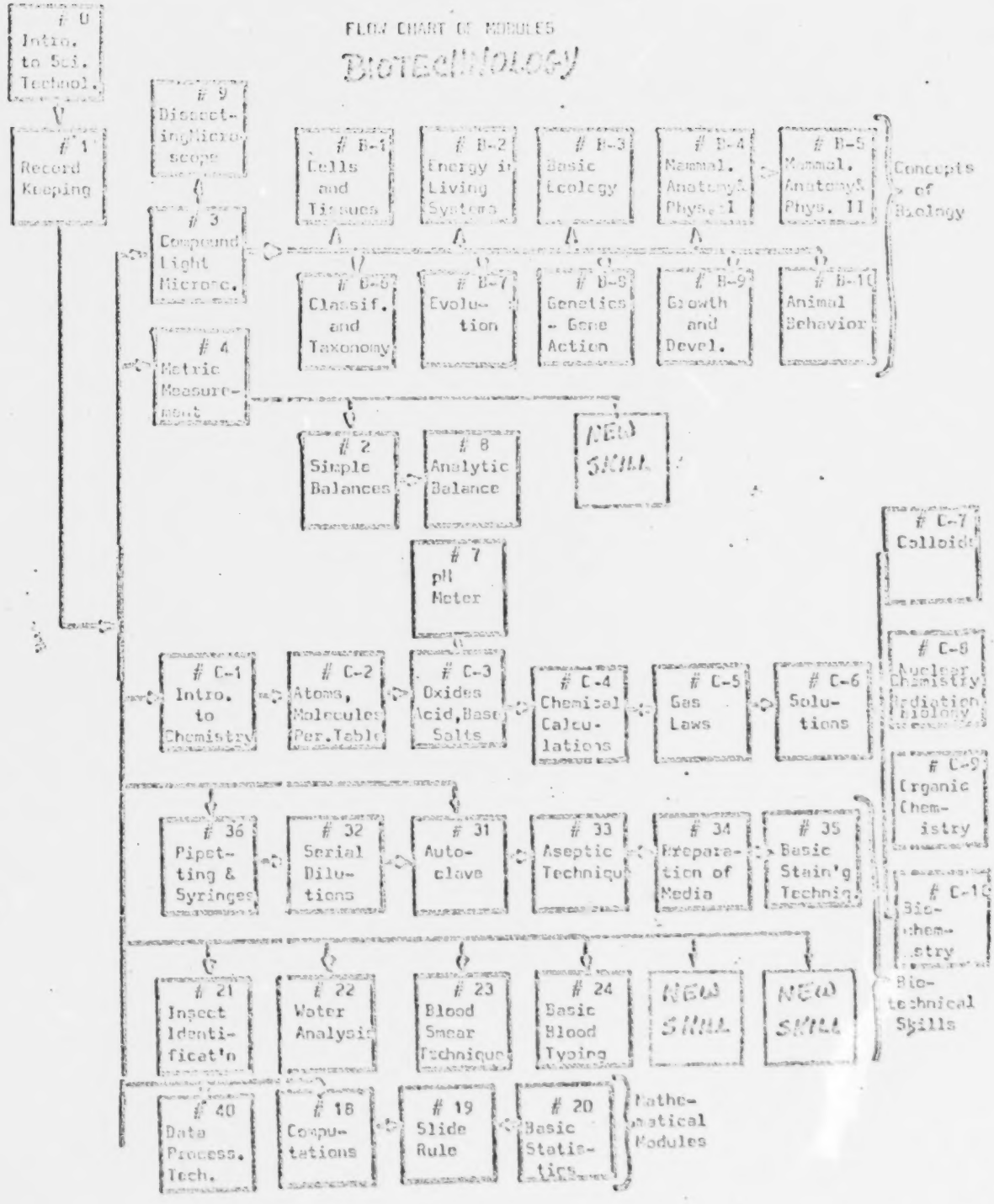
VI. Please add any other comments you feel would be helpful in improving this module.

VII. Submit with this evaluation a list of questions you had to ask about unclear points in the module.

APPENDIX D

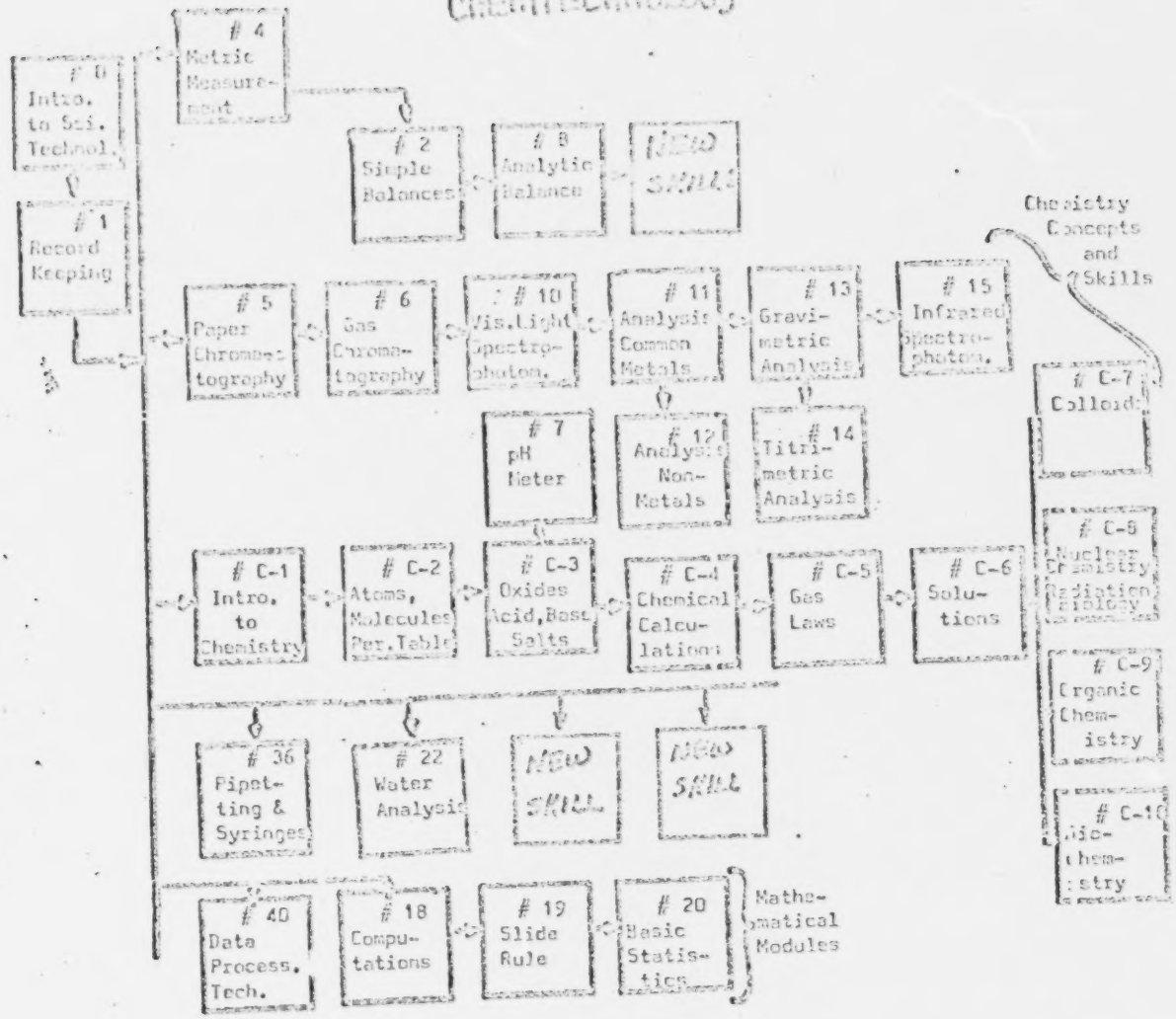
FLOW CHART OF MODULES


0 Intro. to Sci. Technol.
1 Record Keeping
9 Dissecting Microscope
3 Compound Light Microsc.
4 Metric Measurement
2 Simple Balances
8 Analytic Balance
B-1 Cells and Tissues
B-2 Energy in Living Systems
B-3 Basic Ecology
B-4 Mammal. Anatomy & Phys. I
B-5 Mammal. Anatomy & Phys. II
Concepts of Biology
B-6 Classif. and Taxonomy
B-7 Evolution
B-8 Genetics - Gene Action
B-9 Growth and Devel.
B-10 Animal Behavior
Chemistry Concepts and Skills
5 Paper Chromatography
6 Gas Chromatography
10 Vis. Light Spectrophotom.
11 Analysis Common Metals
13 Gravimetric Analysis
15 Infrared Spectrophotom.
7 pH Meter
12 Analysis Non-Metals
14 Titrimetric Analysis
C-7 Colloids
C-1 Intro. to Chemistry
C-2 Atoms, Molecules Per. Table
C-3 Oxides Acid, Base Salts
C-4 Chemical Calculations
C-5 Gas Laws
C-6 Solutions
C-8 Nuclear Chemistry Radiation Biology
C-9 Organic Chemistry
C-10 Biochemistry
36 Pipetting & Syringes
32 Serial Dilutions
31 Autoclave
33 Aseptic Technique
34 Preparation of Media
35 Basic Stain'g Techniq
Biotechnical Skills
21 Insect Identification
22 Water Analysis
23 Blood Smear Technique
24 Basic Blood Typing
40 Data Process. Tech.
18 Computations
19 Slide Rule
20 Basic Statistics
Mathematical Modules


FLOW CHART OF MODULES
Biotechnology
0 Intro. to Sci. Technol.
1 Record Keeping
9 Dissecting Microscope
3 Compound Light Microsc.
4 Metric Measurement
2 Simple Balances
8 Analytic Balance
7 pH Meter
NEW SKILL
B-1 Cells and Tissues
B-2 Energy in Living Systems
B-3 Basic Ecology
B-4 Mammal. Anatomy & Physiol
B-5 Mammal. Anatomy & Phys. II
B-6 Classif. and Taxonomy
B-7 Evolution
B-8 Genetics - Gene Action
B-9 Growth and Devel.
B-10 Animal Behavior
Concepts of Biology
C-1 Intro. to Chemistry
C-2 Atoms, Molecules Per. Table
C-3 Oxides Acid, Base Salts
C-4 Chemical Calculations
C-5 Gas Laws
C-6 Solutions
C-7 Colloids
C-8 Nuclear Chemistry Radiation Biology
C-9 Organic Chemistry
C-10 Biochemistry
36 Pipetting & Syringes
32 Serial Dilutions
31 Autoclave
33 Aseptic Technique
34 Preparation of Media
35 Basic Stain'g Technique
21 Insect Identification
22 Water Analysis
23 Blood Smear Technique
24 Basic Blood Typing
NEW SKILL
NEW SKILL
Biotechnical Skills
40 Data Process. Tech.
18 Computations
19 Slide Rule
20 Basic Statistics
Mathematical Modules

FLOW CHART OF MODULES

CHEMITECHNOLOGY



APPENDIX E. ABSTRACTS OF MODULES

MODULE Zero Introduction to the Science Technology Program

STATEMENT OF PURPOSE

This module is designed to do two things: (1) to tell you about the science technology program and (2) to demonstrate what a module is.

INSTRUCTIONAL OBJECTIVES

After completing this module, the student should be able to:

1. List and describe the nine components of a module.
2. Name three advantages of modules.
3. List five kinds of science technologists employed in the Northern Virginia area.
4. Explain how one "umbrella" program can train several kinds of technicians.

IMPLEMENTERS

In the module box you will find:

color slides a cassette tape a booklet,"The Use of Modules in College Biology Teaching."

In addition you will need:

a slide viewer a tape player with headphones

MODULE 1 Record Keeping

STATEMENT OF PURPOSE

The purpose of this module is to develop the skills of accurate observation and careful recording of data.

INSTRUCTIONAL OBJECTIVES

1. Given a record kept by another technician, list at least five instances in which the record is incomplete or inaccurate.
2. Using the record from objective 1, state three qualities of a good record.
3. Given the instructions in this module or the presentation of data, prepare tables and graphs which clearly reflect observations.
4. Using a bound notebook and the specifications provided in this module, keep a complete record of all your activities in the science technology courses so that your instructor can assess your progress at any time.

IMPLEMENTERS

In the module box you will find only the study guide for this module. In the cabinet with the modules you will find a notebook which has some sample data sheets which are actually used in various laboratories in the area.

In addition you will need:

a bound notebook to keep records in ($8\frac{1}{2}$ x 11)
a looseleaf notebook to keep the module study guides in
a package of graph paper

MODULE 2 Use of Simple Balances

STATEMENT OF PURPOSE

The purpose of this module is to teach the skill of using simple balances--double pan and beam balances--to weight solids and liquids to the nearest 0.1 gram.

INSTRUCTIONAL OBJECTIVES

1. Given samples of solids and liquids, a double pan balance, weights and other supplies, weigh each sample accurately to the nearest 0.1 gram.

2. Given samples of solids and liquids, a beam balance and other supplies, weigh each sample accurately to the nearest 0.1 gram.
3. Using either a double pan balance or a double pan balance, weigh samples to a specified weight to the nearest 0.1 gram with less than 1% error.

IMPLEMENTERS

In the module box you should have:

a beaker	weighing paper	a cassette tape
a spatula	a bottle of NaCl (table salt)	a set of color slides

In addition you will need:

a double pan balance	a beam balance	a slide viewer
a set of weights	a beaker of water	a tape player

MODULE 3 Use of a Compound Light Microscope

STATEMENT OF PURPOSE

The purpose of this module is to teach the skill of using a compound light microscope. You will learn to use the microscope to magnify objects at various powers of magnification including the use of the oil immersion lens to magnify 1000 times. You will learn to measure the diameter of a microscopic field and to focus the microscope on several focal or optical planes in a microscopic specimen. This module uses prepared slides exclusively; to learn to prepare slides you will need to locate modules on slide preparation.

INSTRUCTIONAL OBJECTIVES

Read these objectives over before you begin the module. Refer to them frequently as you go through the modular program. When you are able to do all of the things specified in these objectives you will be ready to take the post-test to demonstrate your mastery of this module.

1. Given a compound light microscope, demonstrate to the satisfaction of your instructor the function of the following parts of the microscope: ocular, objective, iris diaphragm, stage, coarse adjustment, fine adjustment.
2. Given the power of magnification of an ocular and an objective lens, calculate the total magnification with 100% accuracy.
3. Given a prepared microscope slide, demonstrate the use of the 3.5x objective to scan the slide and locate the threads.
4. Using the same slide, demonstrate switching objectives from the 3.5x objective to the 10x objective to the 40x objective. To be acceptable your demonstration must be done efficiently and with a minimum amount of refocusing with a par-focal microscope.
5. Using a transparent ruler, determine the diameter of the microscopic field for the 3.5x objective and for the 10x objective with a 10x ocular in both cases. To be acceptable the diameter must be correct to the nearest millimeter.
6. Using each objective and a prepared slide, demonstrate three focal planes in the object on the slide to the satisfaction of your instructor.
7. Given a prepared slide of clearly defined cells, estimate the length and width of rectangular cells or the the diameter of round cells as seen under the microscope.
8. Based on your work fromobjectives 6 and 7, explain why cells appear as flat, two-dimensional objects when in fact they are three-dimensional structures with volume.

9. Given a prepared slide of clearly defined cells, demonstrate the use of the oil immersion lens. To be acceptable, your demonstration must include application of immersion oil, adjustment of light, and focusing the microscope with the 100x objective in place.

IMPLEMENTERS

In the module box you should have:

a slide box containing:	a bottle of immersion oil
colored thread slide	transparent plastic ruler
a newsprint slide	cassette tape
Allium (onion) root tip slide	a set of 20 color slides
a clean blank slide	a role of transparent tape
several other assorted slides	lens paper

In addition you will need to locate:
a compound light microscope with built-in light and four objectives
a cassette tape player
a slide viewer

MODULE 4 Metric Measurements

STATEMENT OF PURPOSE

This module will teach you the basic ideas about the metric system.

INSTRUCTIONAL OBJECTIVES

Upon completion of this module you should be able to:
1. Explain the need for standard units of measurement.
2. Identify the meter as the basic unit of the metric system.
3. Identify the fact that the metric system is a decimal system, with standardized prefixes for indicating multiples and fractions of the base unit.
4. Identify exponential notation as a convenient method for identifying very large or very small numbers.
5. Associate the appropriate exponential expressions with the standard prefixes of the metric system.
6. Identify the metric standards for length, volume, mass, time and temperature.
7. List the more commonly used units of the metric system and give practical examples of their use.
8. Distinguish between mass and weight.

IMPLEMENTERS

In the module box you will find:

color slides (prepared from film strip)	audio cassette tape
student review sheets	manual with answers

In addition you will need:
a slide viewer
a tape player with headphones

MODULE 7 Use of the pH Meter

STATEMENT OF PURPOSE

In this module, you will learn to use a pH meter to determine the concentration of acids and bases in solutions. This technique is widely used in a variety of technical tasks.

INSTRUCTIONAL OBJECTIVES

1. Given a pH meter with electrodes immersed in distilled water, correctly set up the meter for the measurement of pH.
2. Given a pH meter correctly set up for measuring pH and selected buffer tablets, accurately standardize the pH meter at three different pH values.

3. Given an accurately standardized pH meter and five samples of unknown pH, measure the pH of each sample to the nearest 0.05 pH unit.

IMPLEMENTERS

In the module box, you should have:

3 vials of buffer tablets	5 unknown samples
a set of color slides	a cassette tape
100 ml. graduated cylinder	1 centigrade thermometer
tissue paper	wax marking pencil

In addition you will need:

a Coleman METRION IV pH meter (ask a lab assistant to move the pH meter. It is a delicate instrument and must be handled with care. Do not plug it in until you are instructed to do so).
3 beakers (about 250 ml. size)
distilled water (at least 300 ml.)
a slide viewer
a tape player with headphones

MODULE 8 Analytical Balance

STATEMENT OF PURPOSE

In this module you will learn the skill of weighing materials on the analytical balance. This balance is used to weigh samples accurately to ± 0.0001 gram.

INSTRUCTIONAL OBJECTIVES

1. Given an analytical balance and weighing papers, balance the opposing pans with a weighing paper on each pan. This must be done with 100% accuracy.
2. Given a specific sample of NaCl, find the mass* of the sample to the nearest 0.5 mg.
3. Given the necessary equipment and materials, prepare a 500 mg. sample of NaCl accurate to 0.5 mg.

IMPLEMENTERS

In the module box you will find:

a set of color slides	weighing papers	a spatula
a cassette tape	a metal slug	a bottle of NaCl to prepare a sample of 500 mg.

In addition you will need:

a VOLAND Analytic Balance with weights and cleaning brush (Use it where it is, don't move it!)
a slide viewer
a tape player with headphones

MODULE 9 Use of the Dissecting Microscope

STATEMENT OF PURPOSE

In this module, you will learn to use the dissecting microscope to see fairly small objects more clearly. Most of the objects you will observe with the dissecting microscope are visible to the unaided eye but can be observed or dissected with greater ease using this microscope. You will also learn to use the dissecting microscope to better observe what you are doing in the dissection of a small organism.

INSTRUCTIONAL OBJECTIVES

1. Given an insect or other small but macroscopic specimen on a microscope slide, focus the dissecting microscope sharply on the specimen at both 10x and 20x magnification.
2. Given a dissecting pan, pins, and a preserved specimen of an earthworm, fasten the specimen to the pan and focus the dissecting microscope sharply on the specimen at both 10x and 20x magnification.
3. Given dissecting tools including glass needles, while looking through the dissecting microscope, expose the digestive tract of the earthworm completely with a minimum of disturbance to other structures in the earthworm.

IMPLEMENTERS

In the module box you should have:

microscope slides
dissecting pins
a cassette tape
a set of color slides
dissecting tools (scalpel, scissors, dissecting needles, glass needles)

In addition you will need:

a tape player with headphones
a preserved specimen of an earthworm
a slide viewer
a dissecting pan
a dissecting microscope

MODULE 18 Computations

STATEMENT OF PURPOSE

The purpose of this module is to provide a short review of certain mathematical operations such as factors, products, powers and scientific notation. The module introduces the mathematical basis and development of the slide rule and when you complete this module, you will be ready to do module 19 on the slide rule.

INSTRUCTIONAL OBJECTIVES

1. Given any problems involving factors, products and/or powers, solve the problems with 90% accuracy.
2. Given any numbers express them in scientific (exponential) notation and perform the indicated arithmetic operations with 90% accuracy.
3. Given sufficient information about any measurements, determine the accuracy of measurements and solve the problems with 90% accuracy.
4. Given any problems involving logarithms, solve the problems with 90% accuracy.
5. Given the discussion of the development of slide rule scales, state the mathematical rule involved in such scales.

IMPLEMENTERS

Tutorfilm - Welch 7722D - A Mathematical Introduction to Slide Rule Fundamentals

AUTOTUTOR MACHINE

MODULE 19 Slide Rule

STATEMENT OF PURPOSE

This module will help you to become proficient in using the slide rule to multiply, divide, take squares, square roots, cubes and cuberoots and work with reciprocals and proportions.

INSTRUCTIONAL OBJECTIVES

1. Given any number on either the D or L scale, find its counterpart on the opposite scale with 90% accuracy.
2. Given any two three-digit numbers, multiply on the slide rule and give the product in three significant figures with 90% accuracy.
3. Given a divisor, dividend and slide rule, find the quotient in three significant figures with 90% accuracy.
4. Given problems that require both multiplication and division, solve to three significant figures with 90% accuracy.
5. Given problems with extremely large or small numbers, solve to three significant figures and put answer in correct scientific notation.
6. Given any number, find its reciprocal to three significant figures with 90% accuracy.
7. Given any proportion problem, solve to three significant figures with 90% accuracy.
8. Given any number, find any of the following to three significant figures with 90% accuracy: square, square root, cube, cube root.

IMPLEMENTERS

In the module box there should be:
slide rule
tutor films: Welch 7722-A1 Slide Rule Fundamentals Part I
Welch 7722-A2 Slide Rule Fundamentals Part II
Autotutor machine

MODULE 20 Basic Statistics

STATEMENT OF PURPOSE

This module is designed to teach some basic concepts of statistics and to demonstrate a few applications.

INSTRUCTIONAL OBJECTIVES

1. After completing this modular program, define the following terms: descriptive statistics, inferential statistics, distribution, frequency polygon, mean, median, mode, standard deviation, correlation coefficient, standard error of the mean, t-test, chi-square.
2. Given appropriate data, calculate the mean, mode and median for a set of data, with 90% accuracy (that is, 90% of the information asked for in the test items must be correct).
3. Given appropriate data, calculate the standard deviation of the data with 90% accuracy.
4. Given appropriate data, calculate the correlation coefficient between two variables with 90% accuracy.
5. Given appropriate data, calculate the standard error of the mean with 90% accuracy.
6. Using the t-test and appropriate statistical tables, determine the value of "t" and the probability of obtaining the observed difference between two means with 90% accuracy.
7. Using the chi-square technique and the appropriate statistical table, determine the value of chi-square and the probability of obtaining the observed differences from the expected values with 90% accuracy.

IMPLEMENTERS

The only material you will need is this study guide. If you have access to a desk calculator and have someone to show you how to use it, you will be able to do this module more rapidly. You do not need to memorize formulas. You will be able to use this study guide while taking the post-test.

MODULE 21 How to Find Insect Specimens in the Field

STATEMENT OF PURPOSE

The purpose of this module is to teach the skill of finding a specific insect on the field. For purposes of simplicity, we will deal only with the White-fringed Beetle (Graphognathus).

INSTRUCTIONAL OBJECTIVES

1. Given examples of an insect's main host plants, identify these host plants with 85% accuracy.
2. Given examples of feeding sign on host plants, identify these signs with 100% accuracy.
3. Given where Graphognathus is found and when, demonstrate this knowledge with 100% accuracy.

IMPLEMENTERS

Department of Agriculture Bulletin No. 550
2 feeding sign charts
Graphognathus specimen
8 color slides
cassette tape
cassette tape player
slide viewer

MODULE 22 Water Analysis

STATEMENT OF PURPOSE

The purpose of this module is for the student to learn basic methods of water analysis for the following qualities: ammonia nitrogen, pH, chlorine, chromium, copper, cyanide, iron, nitrate, phosphorous, silica and sulfide. The student will also learn how each contributes to water pollution.

INSTRUCTIONAL OBJECTIVES

1. Given the equipment provided in the water pollution kit, use any water sample you choose, complete each of the 11 tests and report your results accurately.
2. After completing the modular program, describe how each of the 11 qualities might contribute to water pollution and explain why it is hazardous.

IMPLEMENTERS

Student Work Sheet and Guide
Water Pollution Kit
a water sample collected in a clean jar by the student from any source which might be polluted

MODULE 23 Blood Smear Technique

STATEMENT OF PURPOSE

The purpose of this module is to teach the skills of making a blood smear, staining it with Wright's stain, and identifying several cell types.

INSTRUCTIONAL OBJECTIVES

1. Using the equipment provided, prepare a thin smooth blood smear.
2. Stain the smear with Wright's stain so the cell types are recognizable.
3. Identify correctly the following cell types: erythrocytes, eosinophils, basophils, neutrophils, lymphocytes, monocytes and the platelets (which are not strictly speaking true cells).

IMPLEMENTERS

In the module box, you will find:
color slides made from a film strip
cassette tape
blood lancet
alcohol pads
microscope slides
a dropper bottle of Wright's stain

In addition you will need:
paper towels
a slide viewer
a copy of Module Publication - on reserve in library.
a compound light microscope
a tape player with headphones

MODULE 24 Blood Typing Technique

STATEMENT OF PURPOSE

This module is designed to teach you a step-by-step process for determining a blood type and to explain some ideas about transfusion.

INSTRUCTIONAL OBJECTIVES

After completing this module, you should be able to:

1. List four human blood types and the percentage of each type in the population
2. Explain why a person must receive his or her own type of blood.
3. Explain why anti-sera are used for typing
4. Determine correctly the blood type of a sample specimen.

IMPLEMENTERS

In this kit you will find:

color slides (prepared from a film strip)
anti-a sera
sterile lancets
stirring spatulas
an audio cassette tape
anti-b sera
cotton sponges
slide guide

In addition you will need:

a slide viewer
a tape player with headphones

MODULE 31 Autoclave

STATEMENT OF PURPOSE

This module teaches the basic skill of operating an autoclave to sterilize materials used in aseptic techniques.

INSTRUCTIONAL OBJECTIVE

Given the instructions in this module, sterilize a mixed load of laboratory materials at the appropriate temperature and time to assure sterility.

IMPLEMENTERS

In the module box you will find color slides. You will also need access to the autoclave (Castle Model 999-C) and some materials which need autoclaving. Check with your instructor for these materials.

MODULE 32 Serial Dilutions

STATEMENT OF PURPOSE

This module will teach you how to make accurate serial dilutions.

INSTRUCTIONAL OBJECTIVES

1. Given a bottle of safranin, pipettes, and four test tubes, accurately perform a serial dilution in three minutes.
2. After completing the module, explain (a) how to reach a 1:100,000 dilution, a 1:16 dilution (b) why a clean pipette is used

IMPLEMENTERS

In the module box you will find:

color slides
safranin dye solution
four test tubes

In addition you will need:

a beaker of water
a slide viewer
eight 1 ml. pipettes
a test tube rack

MODULE 33 Aseptic Techniques

STATEMENT OF PURPOSE

This minicourse instructs the student in some of the basic techniques used in the study of microbiology. Included are instructions on how to make a transfer and two different isolation techniques utilizing a streak plate and a diluted pour plate. The importance of using aseptic technique is stressed throughout. In addition, the role of microorganisms in the environment and their relationship to man is introduced.

INSTRUCTIONAL OBJECTIVES

Upon completing this minicourse the student should be able to:

1. Describe differences between the natural environment of the microbial world and the artificial environment created for microbes in the laboratory.
2. Give reasons for creating an artificial environment for culturing microorganisms in the laboratory.
3. Describe the origin and properties of agar and explain why it is useful in microbiology.
4. Perform a transfer of bacteria from a liquid stock culture to a sterile nutrient broth tube given a broth culture containing two species of bacteria, a sterile nutrient broth tube, an inoculation loop and a bunsen burner. Both tubes must be maintained free from contamination. Acceptable performance is a contamination-free culture, determined by making a streak plate in which not more than two kinds of microorganisms are present.
5. Perform isolation of bacteria using the agar streak plate method, given the newly inoculated broth tube and a sterile nutrient agar petri plate. Acceptable performance will be demonstrated if the plate shows well separated colonies.
6. Prepare pour plates of a serial loop dilution in order to isolate bacteria from a mixed and concentrated culture. Acceptable performance will be demonstrated if a plate with well separated colonies is produced.

IMPLEMENTERS

In the module box you will find pictures of bacteria, a film (8mm. movie) a cassette tape. You will need a tape player with headphones and an 8 mm. movie projector from the audiovisual department. Check with the lab assistant to obtain the rest of the materials listed on p. 3 of the instructor's guide.

MODULE 36 Pipetting and Syringes

STATEMENT OF PURPOSE

This module will teach you how to use and care for pipettes and syringes.

INSTRUCTIONAL OBJECTIVES

After completing this module, you should be able to:

1. Care for pipettes and syringes properly.
2. Fill and empty a pipette correctly and accurately.
3. Fill and empty a syringe correctly and accurately.

IMPLEMENTERS

In the module box you will find:

color slides
test tubes
cassette tape
safranin dye

In addition you will need:

slide viewer
test tube rack
tape player with headphones
1 ml. and 5 ml. pipettes (blow-out and non-blow-out type)
syringe with needle (disposable)

Be sure to return the syringe to your instructor when you are finished with it.

MODULE 40 Data Processing Techniques

STATEMENT OF PURPOSE

This module will give you a basic knowledge of computing systems, terminology, programming and numbering systems so you will be able to interact with a data processing department.

INSTRUCTIONAL OBJECTIVES

1. Name in sequence and describe the five steps in any data processing problem.
2. Explain how numeric and alphameric data are represented on a punched card.
3. Define or describe binary, decimal and hexadecimal number systems, magnetic storage, tape storage and disk storage.
4. Explain briefly what a computer program does and include in your explanation a definition of each of the following: conditional branch, unconditional branch, loop and arithmetic operation, FORTRAN, COBOL, PL/1.

IMPLEMENTERS

You will need the programmed instruction book entitled Computing Systems Fundamentals: Overview book which is on reserve in the learning resources center.

MODULE E-1 Cells and Tissues

STATEMENT OF PURPOSE

This module introduces basic biological concepts and describes the properties of human cells and tissues through the use of a programmed text. In addition there are photographic color slides of cell organelles and microscope slides of various cell and tissue types.

INSTRUCTIONAL OBJECTIVES

1. After completing chapter 1, define: biology, anatomy, histology, physiology, element, atom, molecule, compound, electron, proton, neutron, ion, electrolyte, protoplasm motility, irritability, metabolism, reproduction.
2. After completing chapter 2 and viewing the photographic slides, describe the structure and function of each of the following components of a cell: cell membrane, mitochondria, inclusions, nucleus, ribosome DNA, RNA, chromosome, nuclear membrane.
3. After completing chapter 3 and viewing the microscope slides of various types of tissues, distinguish among the five types of tissue by structure and function.

IMPLEMENTERS

In the module box you should find:	In addition you will need:
microscope slides of various tissues	a compound light microscope
photographic slides of cells	a slide viewer
cassette tape	a tape player
	the programmed text, Basic Concepts of Anatomy and Physiology (Ch. 1, 2 and 3)

MODULE E-4 Mammalian Anatomy and Physiology I (skin, skeleton, muscles: circulatory and respiratory systems)

STATEMENT OF PURPOSE

This module will teach you the basic structure and function of the systems listed in the title. You will learn about human anatomy from models and the programmed instruction book you used in module E-1. You will also learn about another mammal, the fetal pig, by dissecting a preserved specimen.

INSTRUCTIONAL OBJECTIVES

1. After completing the programmed instruction on the integumentary system, describe (a) distinguishing characteristics of epidermis, dermis, and subcutaneous tissue, (b) three components of the integument besides skin, and (c) four functions of the integument.
2. After completing the programmed instruction on the muscular skeletal system, describe (a) the distinguishing characteristics of bone, cartilage, tendon, ligament, and muscle (b) three kinds of levers formed by muscles and bones.
3. After completing objectives 1 and 2 above and after completing chapters 1, 2, and 3 of Laboratory Anatomy of the Fetal Pig, (a) list three similarities and three differences in the human and pig skeletons and (b) demonstrate with your own limbs the following muscles: flexor, extensor, abductor, adductor, rotator, constructor.

4. After completing the programmed instruction on the respiratory system and chapter 8, of the laboratory manual (a) describe in order the structures through which air passes during inspiration and expiration (b) describe the function of each structure and (c) list 3 similarities and 3 differences in human and pig respiratory systems.
5. After completing the programmed instruction on the circulatory system and chapter 7 of the laboratory manual, (a) list distinguishing characteristics of arteries, veins, capillaries and lymph vessels (b) trace the flow of blood through the mammalian heart (c) list three similarities and three differences in the human and pig circulatory systems and (d) name the part(s) of the body served by the following blood vessels: carotid arteries, renal arteries and veins, hepatic portal vein, subclavian arteries and veins, and iliac arteries and veins and hepatic artery.
6. After completing the five objectives above, summarize in your own words (300-500 words) the function of each system studied and the relationships among these systems.

IMPLEMENTERS

In addition to this pamphlet you will need the programmed instruction book: Basic Concepts of Anatomy and Physiology by Dean, Farrar and Zoldos. You will also need the laboratory manual: Laboratory Anatomy of the Fetal Pig by Odlaug. a preserved fetal pig specimen, dissecting tools, a human skeleton, models of human torso (male and female).

MODULE B-5 Mamalian Anatomy II (Endocrine, Nervous, Genito-urinary and digestive systems)

STATEMENT OF PURPOSE

This module will teach you the basic structure and function of the systems listed in the title. You will learn about human anatomy from models and the programmed instruction book you used in module B-1. You will also learn about another mammal, the fetal pig, by dissecting a preserved specimen.

INSTRUCTIONAL OBJECTIVES

1. After completing the programmed instruction on the nervous system (a) describe the basic structure and function of a neuron, a synapse, myelin sheath, meninges, the cerebrum, cerebellum, pons, medulla oblongata, thelamus, hypothalamus, spinal reflex, (b) differentiate between: motor and sensory, cranial and spinal nerves, sympathetic and parasympathetic nervous system, central and peripheral nervous system.
2. After completing the programmed instruction on the endocrine system, describe the hormones produced and functions of the following glands: thyroid, parathyroid, adrenals, pancreas, gonads and pituitary.
3. After completing the programmed instruction on the genito-urinary system, describe briefly the function of the male reproductive system, the female reproductive system and the urinary system.
4. After completing the programmed instruction on the digestive system, describe briefly the location and function of the following organs: mouth, pharynx, esophogus, stomach, small intestine, large intestine, liver gall bladder and pancreas.
5. After completing in the laboratory manual chapter 4 - general internal anatomy and chapter 5 digestive system, identify for your instructor the digestive organs of the fetal pig.

6. After completing in the laboratory manual chapter 6 - the uropenital system, identify for your instructor the following structures in the fetal pig: ovaries, uterus, vagina, testes, spermatic cord, urethra, bladder, kidney and ureter.
7. After completing in the laboratory manual chapter 9 - nervous system, identify for your instructor the following structures: meninges, cerebrum, cerebellum, medulla oblongata, pons, any three cranial nerves, spinal cord, and spinal nerve; and in the eye: pupil, iris, sclera, lens and retna.

SUPLEMENTERS

In addition to this pamphlet, you will need the programmed instruction book: Basic Concepts of Anatomy and Physiology by Dean, Farrar, and Zoldos. The laboratory manual: Laboratory Anatomy of the Fetal Pig by Odlaug. You will also need a preserved fetal pig specimen, dissecting tools, a human skeleton, models of human torso(male and female).

MODULE B-8 Cell Reproduction, Genetics and Gene Action

STATEMENT OF PURPOSE

This module which makes use of programmed instruction will give the user an introduction to the basic concepts of genetics. There are six parts to the module: (1) cell reproduction (2) basic mendilian genetics (3) sex determination, linkage and chromosome mapping (4) complex inheritance patterns (5) morphology and physiology of genes and (6) cytoplasmic inheritance and population genetics.

INSTRUCTIONAL OBJECTIVES

1. After completing part 1, define accurately each of the following terms: cytokinesis, mitosis, meioses, homologous, diploid, haploid, zygote, gamete, chromatid, tetrad, dyad, synapsis, spermatogenesis, oogenesis, crossing-over, fertilization.
2. After completing part 2, distinguish between each of the following pairs of terms: dominant and recessive, genotype and phenotype, homozygous and heterozygous, monohybrid and dihybrid, gene and chromosome, locus (loci) and allele (s) .
3. After completing part 2 and given sufficient information, determine the probabilities of each genotype and phenotype in any monohybrid cross, test cross or dihybrid cross.
4. After completing part 3 and given sufficient information, determine the nature of the gametes (and their combinations where appropriate) for each of the following phenomena: (a) sex determination (b) linkage and (c) chromosomal mapping.
5. After completing part 4 and given sufficient information, identify examples of the following complex inheritance patterns: (a) complementary genes, (b) polygenic inheritance and (c) multiple alleles.
6. After completing part 5, briefly describe (a) gene function (b) protein synthesis (c) cytoplasmic inheritance and (d) gene frequency changes in population genetics.

IMPLEMENTERS

Programmed instruction book: An Introduction to Genetics by E. J. Kormondy. You may want to refer to one of the texts listed under references (p. xi) in Kormondy's book or you may want to use a general biology book as a reference.

MODULE 10 Animal behavior

STATEMENT OF PURPOSE

The purpose of this module is to introduce some basic concepts of animal behavior. These will include a definition of behavior, the formulation of hypotheses and generalizations about types of behavior, and some aspects of learning, communication, social behavior and time and space orientation. Upon completion of this module, you should have mastered the basic concepts as defined in the instructional objectives. This level of mastery is comparable to that likely to be attained in a general biology course. As a technician you will be better prepared to handle animals and you will be ready to learn to assist with research in animal behavior.

INSTRUCTIONAL OBJECTIVES

1. After reading the materials provided, write a definition of behavior which accounts for at least four characteristics of behavior.
2. Given a list of observable animal behaviors, formulate a hypothesis that explains a behavior and state a general principle that applies to several of the behaviors given. To be acceptable, your statement of a general principle must incorporate two or more hypotheses.
3. Given descriptions of several kinds of behavior, distinguish between inherited and learned behavior. To be acceptable, your answer must include reasons for why a behavior is classified as inherited or learned or a combination of the two.
4. Given a list of learned behaviors and any references you choose, identify examples of each of several types of learned behavior. To be acceptable, your answers must include a reason for each classification.
5. Given the factors (a) motivation, (b) reinforcement, (c) releasers, explain how each of the factors affect behavior in general and learning in particular. To be acceptable, your explanations must demonstrate that you can define each of the factors in terms of their effect on behavior.
6. Given a list of animals, select any three and describe for each its method of intra-species communication. To be acceptable, your descriptions must include two distinguishing characteristics of the communication within each species.
7. Given the resources of the Washington Zoo, make a brief study of communication among the animals in the zoo and write a 200 word report of your observations.
8. Using any references you choose, describe an example of each of the following types of social behavior: (a) mating ritual, (b) social dominance, and (c) displacement activity. To be acceptable, your descriptions must include three characteristics of each type of behavior.
9. Using any references you choose, describe three different examples of territoriality. To be acceptable, your descriptions must must include three characteristics of each type of behavior.
10. Using any references you choose and any suitable location to make observations, describe at least three attributes of aggressive behavior.

11. Using any references you choose, list three examples of animals that can maintain their bearings in geographic space and describe the behavior that has been observed on these animals. To be acceptable, your description must include three characteristics of the orientation behavior.
12. Given a list of instruments used by humans to maintain their orientation in space, contrast these with the animal behaviors in the objective above. To be acceptable, your contrasts must include three similarities and three differences.
13. Using any references you choose, describe at least three characteristics of behavior which indicates the presence of some type of "biological clock" mechanism.
14. Given what you have learned about biological clocks, describe three ways in which such clocks enhance the organism's chances for survival.

IMPLEMENTERS

In the module box you will find:

color slides	a cassette tape
a reading list	a script for the cassette tape

In addition you will need:

a slide viewer	a tape player with earphones

MODULE C-1 Introduction to Chemistry

STATEMENT OF PURPOSE

The purpose of this first module in basic chemistry is to introduce you to the study of chemistry - the study of matter. You will learn a number of basic definitions and concepts essential to more detailed studies of chemistry.

INSTRUCTIONAL OBJECTIVES

1. Without reference to notes, define the following terms and phrases accurately: matter, energy, law of conservation of matter, law of conservation of energy.
2. Given a list of changes, differentiate between those that are physical changes and those that are chemical changes with 100% accuracy.
3. Without reference to notes, name and give two examples of each of the three states of matter with 100% accuracy.
4. In terms of molecular motion and energy, explain how matter changes from one state to another.
5. Without reference to notes, define the following terms and phrases accurately: element, compound, mixture, law of definite proportions, density, specific gravity, heat, heat intensity, heat quantity, calorie.
6. Given the weight and volume of certain samples, calculate their density and specific gravity with 90% accuracy.
7. Given any temperatures on either the Celsius (Centigrade) scale or the Fahrenheit scale and the conversion formula, convert the temperatures to the opposite scale with 90% accuracy.

IMPLEMENTERS

Brooks' Basic Chemistry - A programmed presentation, Part I p. 1-7

MODULE C-2 Atoms, Molecules and the Periodic Table

STATEMENT OF PURPOSE

The purpose of this module is to help you to master the basic ideas about atomic structure, valance, how atoms combine to form molecules, the notation of chemistry, some basic kinds of chemical reactions, and an overview of the order of elements in the periodic table.

INSTRUCTIONAL OBJECTIVES

1. Without reference to notes, define atom, proton, neutron, electron, isotope, atomic number, atomic weight, with 100% accuracy.
2. Given the atomic particles of any atom, draw a diagram of the atomic structure and give the atomic number and atomic weight to the nearest whole number with 90% accuracy.
3. Without reference to notes, define ion, electrovalance, co-valence, radical with 90 % accuracy.
4. Given any set of atoms or ions, determine whether they could combine chemically, and if so, name the kind of bond with 90% accuracy.
5. Without reference to notes, define molecule, equation, reactant, product with 90 % accuracy.
6. Given chemical names of compounds and a table of valances, write chemical formulas for each compound with 90% accuracy.
7. Given word equations for chemical reactions, write balanced chemical equations for each reaction with 90% accuracy.
8. Without reference to notes, define dissociation, electrolyte, cathode, anode, oxidation, reduction, endothermic, exothermic, reversible, irreversible with 100% accuracy.
9. Without reference to notes, list five factors which affect the rate of a chemical reaction with 100% accuracy.
10. Given the periodic table as a reference, use it to explain (a) the relationship between periods in the table and electron shells and (b) why elements in the same group have similar properties.

IMPLEMENTERS

Brooks' Basic Chemistry - A programmed presentation, Parts II and III, p. 8-36

MODULE C-3 Oxides, Acids, Bases and Salts

STATEMENT OF PURPOSE

In this module you will study the preparation, properties, reactions and nomenclature of commonly encountered classes of inorganic compounds-- oxides, acids, bases and salts.

INSTRUCTIONAL OBJECTIVES

1. Without reference to notes, define the following terms with 100% accuracy: oxide, acid, base, salt, amphoterism, hydrolysis and the Bronsted-Lowry Theory.
2. Without reference to notes, distinguish between metallic anhydrides and non-metallic anhydrides with respect to their names, their reactions and the methods of preparing them, with 90% accuracy.
3. Without reference to notes, describe (a) the relationship of hydrogen ions to the strength of acids, (b) the rules for naming acids and (c) a method for preparing acids, with 90% accuracy.

4. Without reference to notes, describe (a) the relationship of the hydroxyl ion to the strength of bases, (b) the rules for naming bases and (c) a method for preparing bases, with 90% accuracy.
5. Without reference to notes, describe (a) a neutralization reaction, (b) the rules for naming salts and (c) three methods for preparing a salt, with 90% accuracy.

IMPLEMENTERS

Brooks' Part IV, p. 37-43.

MODULE C-4 Chemical Calculations

STATEMENT OF PURPOSE

In this module you will learn to do calculations involving molecular weights, percentages and problems involving weight and volume.

INSTRUCTIONAL OBJECTIVES

1. Given a molecular formula for any compound and a table of atomic weights of elements, calculate the molecular weight of the compound and determine the weight in grams of a specific number of moles of the compound, with 100% accuracy.
2. Given sufficient data, determine the percentage composition of any elements in a compound with 100% accuracy.
3. Given a description of a reaction including the quantity of one reactant or product, determine the weights of all other reactants and products to react exactly with the given quantity with 90% accuracy.
4. Given a description of a reaction involving a gas and the weight of one substance in the reaction, find the volume of gas to react exactly with the given quantity with 90% accuracy.
5. Given a description of a reaction involving two or more gases and the volume of one gas, find the volume of the other gases to react exactly with the given quantity with 90% accuracy.

IMPLEMENTERS

Brooks' Basic Chemistry, Part V, p. 49-52

MODULE C-5 Gas Laws

STATEMENT OF PURPOSE

This module deals with the properties of gases in terms of Boyle's, Charles', Dalton's, Graham's, Gay-Lussac's and Avogadro's Law.

INSTRUCTIONAL OBJECTIVES

1. Given formulas and data, use Boyle's Law and/or Charles' Law to determine an unknown temperature, volume or pressure of a gas with 90% accuracy.
2. Given a formula and data, use Dalton's Law to determine partial or total pressures of gases in mixtures with 90% accuracy.
3. Given a formula and data, use Graham's Law to determine the relative diffusion rate of gases with 90% accuracy.
4. Given a chemical equation, use Gay-Lussac's Law to determine the relative volumes of each gas in the equation and use Avogadro's Law to determine the relative number of molecules of each gas with 90% accuracy.

IMPLEMENTERS

Brooks' Basic Chemistry, Part VI, p. 53-57

MODULE C-6 Solutions

STATEMENT OF PURPOSE

In this module you will learn about various properties of solutions and how to express concentrations of solutions in percentages, molarity and normality. You will learn some basic ideas about pH and buffers, boiling and freezing points and osmosis. The concepts developed in this module are essential in performing many of the skills a technician uses routinely.

INSTRUCTIONAL OBJECTIVES

1. Without reference to notes, define the following terms with 100% accuracy: solute, solvent, solution, saturated solution, unsaturated solution, supersaturated solution, crystalline, miscible.
2. Given the appropriate data, express the percentage concentration of a solute in a solvent or determine the amount of solute required to prepare a given concentration with 90% accuracy.
3. Given the appropriate data, express the molar concentration of a solute in a solvent or determine the amount of solute required to prepare a given molarity with 90% accuracy.
4. Given the appropriate data, express the normal concentration of a solute in a solvent or determine the amount of solute required to prepare a given normality with 90% accuracy.
5. Without reference to notes define the terms, buffer and pH so that you could use this information in determining pH.
6. Given appropriate data, explain the effect of a solute on boiling and freezing points so that you could determine either the concentration knowing the boiling and freezing points or calculate the boiling and freezing points knowing the concentration.
7. Using the principle of osmosis, determine whether and how the concentration of water would change inside a cell placed in hypotonic, isotonic or hypertonic solutions with 100% accuracy.

IMPLEMENTERS

Brooks' Part VII, p. 58-73

MODULE C-7 Colloids

STATEMENT OF PURPOSE

In this module you will learn about some of the properties of colloids related to particles size, electrical charges and surface area. Since many of the problems science technicians encounter have to do with colloids, this module should beuseful to you in the future.

INSTRUCTIONAL OBJECTIVES

1. Without reference to notes, write a definition of a colloid which will distinguish it from solutions.
2. Without reference to notes, list an example six different types of colloids based on the types of matter making up the colloid with 100% accuracy.
3. Without reference to notes, explain the Tyndall effect and Brownian movement as they relate to colloids.
4. Without reference to notes, explain the basic principle of electrophoresis in terms of colloidal properties.
5. Without reference to notes, define adsorption in terms of particle size.
6. Without reference to notes, explain the basic principle of dialysis in terms of particle size.

IMPLEMENTERS
Brooks' Basic Chemistry, Part VIII, p. 74-79

MODULE C-8 Nuclear Chemistry and Radiation Biology
STATEMENT OF PURPOSE
In this module you will learn about various radioactive particles and their potential for damaging living cells. You will also learn the basic ideas of transmutation, isotopes, fission and fusion.
INSTRUCTIONAL OBJECTIVES
1. Without reference to notes, define radioactivity and describe the nature of alpha particles, beta particles and gamma rays in terms of their structure, formation and decay, with 90% accuracy.
2. For each of the following alpha particles, beta particles and gamma rays, describe the nature and degree of damage they can do to living cells with 90% accuracy.
3. Without reference to notes, describe briefly transmutation, isotope, fission, and fusion.
IMPLEMENTERS
Brooks' Basic Chemistry Part IX p. 80-87.

MODULE C-9 Organic Chemistry
STATEMENT OF PURPOSE
In this module you will learn about the basic structures and properties of several types of organic compounds: hydrocarbons, alcohols, acids, aldehydes, ketones, amines and amino acids.
INSTRUCTIONAL OBJECTIVES
1. Given the empirical formulas for simple organic compounds, write structural and abbreviated formulas with 90% accuracy.
2. Without reference to notes, define with 100% accuracy the following terms: organic compound, saturation, unsaturation, polymerization.
3. Given structural formulas for selected organic compounds, identify each as a chain, carbocyclic ring or heterocyclic ring and determine whether the compound is saturated or unsaturated with 90% accuracy.
4. Given structural formulas for hydrocarbons, identify alkanes, alkenes, alkynes, cycloparaffins, and benzenes with 90% accuracy.
5. Given structural formulas for halogenated hydrocarbons and alkane substituted hydrocarbons, name each compound according to the nomenclature rules, with 90% accuracy.
6. Given structural formulas, name the compound and describe at least one characteristic property of each of the following types of compounds, with 90% accuracy: alcohols, acids, aldehydes, ketones, amines and amino acids.
IMPLEMENTERS
Brooks' Basic Chemistry, Part X, p. 88-109.

MODULE C-10 Biochemistry
STATEMENT OF PURPOSE
In this module you will learn about the basic chemical structure of classes of compounds found in living organisms. You will also learn some fundamental ideas about metabolism - the chemical processes that occur in living organisms. Enzymes, vitamins, minerals, hormones and body fluids are also described briefly in this module.

INSTRUCTIONAL OBJECTIVES Without reference to notes,

1. define with 90% accuracy the terms: enzyme, "ase", substrate, and product, proenzyme, protease, esterase, carbohydrase, hydrolase, dehydrogenase, oxidase, transferase, isomerase, vitamin.
2. define and give an example, with 90% accuracy, the terms: carbohydrate, hormone, monosaccharide, disaccharide, polysaccharides, anaerobic, aerobic and ATP.
3. write a word equation and explain the significance of the following reactions: (a) photosynthesis, (b) anaerobic respiration and (c) aerobic respiration, so that reactants, products and energy changes are accounted for.
4. define ester, simple lipid, phospholipid with 90% accuracy.
5. define protein, amphoteric, DNA, RNA, anabolic, catabolic, deamination with 90% accuracy.
6. define hormone and describe the function of at least two hormones with 90% accuracy.
7. list at least 6 components of blood, describe the mechanism for blood clotting, and write two equations which act to control the pH of blood, with 90% accuracy.
8. list accurately five characteristics of urine.
9. define and describe briefly inorganic metabolism.

IMPLEMENTERS

Brooks' Basic Chemistry, Part XI, p. 110-134

MODULE C-11 Safety in the Laboratory

STATEMENT OF PURPOSE

In this module you will study the standard safety practices and some special hazards particular to the chemical laboratory.

INSTRUCTIONAL OBJECTIVES

1. Locate and demonstrate the use of personal protection equipment.
2. Without reference to notes, define the following terms with 100% accuracy: flammable limits, flash point, ignition temperatures, auto-ignition temperature, combustible liquids, and pyrophoric materials.
3. Without reference to notes, describe suggested procedures to avoid accidents in handling the following items: sodium, mercury, and peroxides.
4. List some common precautions to consider in using larger laboratory equipment.

DIAGNOSTIC PRE-TEST

Take pre-test which will demonstrate your familiarity with the safety practices.

IMPLEMENTERS

Laboratory Safety Equipment

MODULE C-12 Basic Chemical Laboratory Practice

STATEMENT OF PURPOSE

In this module you will become familiar with general laboratory equipment and learn how to manipulate the equipment safely.

DESIRABLE PREREQUISITE SKILLS

Module C-11 Safety in the Laboratory

INSTRUCTIONAL OBJECTIVES

1. Without reference to notes and diagrams, identify with 100% accuracy the general laboratory equipment (flasks, pipettes, burners, etc.).
2. Read a typical reagent label and identify the various sections with 100% accuracy.
3. Without reference to notes, demonstrate the following skills:
   a. handling laboratory glass tubing and glassware
   b. operating a burner
   c. handling and pouring reagents, and
   d. assembling standard taper joint glassware
4. Without reference to the modular program, list several general safety hints when handling the general bench equipment.

DIAGNOSTIC PRE-TEST

Demonstration of basic laboratory skills for the instructor.

IMPLEMENTERS

Bench laboratory equipment represented in the attached figures of the module.

MODULE C-13 Chemical Literature and the Library

STATEMENT OF PURPOSE

This module will afford you the opportunity to get acquainted with chemical references and assist you in developing good library skills necessary for laboratory technician work.

DESIRABLE PREREQUISITE SKILLS

General college level library skills

INSTRUCTIONAL OBJECTIVES

1. Without notes, distinguish between primary and secondary sources of information.

2. List and describe with 100% accuracy the kinds of publications beneficial to chemical laboratory work.
3. Demonstrate your use of library facilities by locating specific chemical publications.

DIAGNOSTIC PRE-TEST

Location of specified abstracts and chemical texts for the instructor.

IMPLEMENTERS

Library facilities

MODULE C-14 Toxicity of Chemicals

STATEMENT OF PURPOSE

This module was selected from the Chemical Technician Project (American Chemical Society). It is designed to familiarize you with the hazards of toxic and/or poisonous chemicals.

INSTRUCTIONAL OBJECTIVES

1. Define the following terms: toxicology, toxicity, hazard, systematic, local, topical, acute, chronic, threshold limit valve, concentration, and tolerance.
2. Distinguish between the three (3) common ways in which toxic chemicals enter the body.
3. List several toxic agents found in the general chemical laboratory.
4. Given the appropriate information, identify whether the agent is carbon monoxide, mercury vapor, hydrogen sulfide, carbon tetrachloride, and benzene.

DIAGNOSTIC PRE-TEST

Identify and list some of the hazards associated with the prepared list of toxic agents.

IMPLEMENTERS

Toxicity of Chemicals (the modular program) by American Chemical Society.

MODULE C-15 Hazards--Electricity and Compressed Gases

STATEMENT OF PURPOSE

In this module you will study the properties of electrical equipment and the precautions in their usage. The manipulation of compressed gas cylinders will be studied to aid you in safe handling of the high pressure containers.

DESIRABLE PREREQUISITE SKILLS

Safety in the Laboratory

INSTRUCTIONAL OBJECTIVES

1. Without reference to notes and diagrams, explain the relation among force, current and resistance (Ohm's Law).
2. Without reference to notes, define with 100% accuracy the following terms: volt, ampere, ohm, regulator and pressure gauge.
3. Demonstrate the proper method of transporting a cylinder and the attaching and use of a regulator.
4. List some of the safety considerations in the handling of electrical equipment and of compressed gas cylinders.

DIAGNOSTIC PRE-TEST

Demonstrate your ability to handle compressed gas cylinders and explain Ohm's Law.

IMPLEMENTERS

Compressed gas cylinders, regulators, and standard laboratory electrical equipment.

MODULE C-16 Paper Chromatography

STATEMENT OF PURPOSE

This module is designed as an introduction to qualitative analysis to identify components of mixtures. The method chosen for this is paper chromatography.

DESIRABLE PREREQUISITE SKILLS

Metric Measurement Module, Chemistry for Laboratory Technicians, pages 198-206.

INSTRUCTIONAL OBJECTIVES

1. Distinguish between quantitative and qualitative analysis.
2. Identify the following terms: mixture, standard samples, chromatograms.
3. Perform the paper chromatography exercise, separating a known sample.

DIAGNOSTIC PRE-TEST

Demonstrate the procedure to successfully perform paper chromatography of a known sample.

IMPLEMENTERS

400 ml beaker	watch glass
metric ruler	paper clips
stick	droppers
strips of filter paper	toothpicks
paper towels	

UNIVERSITY OF CALIF.
LOS ANGELES

JUL 27 1973

CLEARINGHOUSE FOR
JUNIOR COLLEGE
INFORMATION